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Title: Engaging online students through peer-comparison progress dashboards

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Abstract

Purpose - Students studying exclusively online face the challenge of gauging their progress in relation to that of their disparate peers. This paper describes the creation of a student progress 'dashboard' in an online Masters programme, and the perceived effectiveness of the tool for engaging students.

Design/methodology/approach -Tableau® visualization software was used to create a dashboard displaying cohort comparison data comprising metrics relating to the continuous assessment components of the Masters programme. An anonymous questionnaire gauged students' perceptions of the dashboard.

Findings - Feedback from students (n=137) suggests the dashboard improved their motivation, incentivising change in study behaviours, and sense of belonging to an online community of learners. It also acted as a conversation catalyst between staff and students, whereby students more readily engaged in dialogue with their personal tutor.

Practical implications - Distance learners are more likely to feel isolated and can become demotivated, which contributes to typically higher levels of withdrawal from online programmes versus those delivered on-campus. Tutors may consider communicating progress data as dashboards to enable online students to monitor their academic progress alongside that of their peers, as a motivational tool in an otherwise disparate group of learners, and to reduce feelings of isolation by reminding distance learners that they are part of a larger online community.

Originality/value - This paper shares student and tutor perspectives on the use of dashboards to increase online students' motivation, and examines whether the benefits of a peer-comparison dashboard are reserved for high-achieving students.

Keywords Online students, Learning analytics visualisations, Dashboard, Personal tutor

Paper type Case study

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Introduction

Successful personal tutoring in higher education, in terms of student retention and performance, includes proactive student academic and pastoral support, and monitoring participation (Thomas *et al*., 2017; Walker, 2018). With increasing demands on academics' time, personal tutoring has been seen as an unsustainable aspect of the role (Macfarlane, 2011). Furthermore, online, distance-learning courses present a particular challenge to tutors in enabling students to gauge their progress alongside that of their geographically disparate peers. Measures to make personal tutor interaction with online students more effective and efficient are warranted.

The purpose of this case study is to illustrate how a progress 'dashboard' can be used by personal tutors for online courses to provide effective student support as well as reinforce in students their sense of belonging to an online community. The objectives of the dashboard were to permit students to monitor their progress easily in relation to their peers, and for tutors to better identify student engagement and prompt effective interventions. Students' perceived self-efficacy affects their motivation level (Bandura, 1994); if they believe they possess the skills to succeed, they persevere regardless of challenges and can apply skills learned more effectively in the future. Such self-efficacy can be strengthened through social models, as Bandura observes, "*Seeing people similar to oneself succeed by sustained effort raises observers' beliefs that they too possess the capabilities to master comparable activities required to succeed.*" (Bandura, 1994).

The questions addressed in this paper are:

- Do peer-comparison dashboards increase online student motivation?
- Do high-performing students benefit most from a peer-comparison dashboard?

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Literature review

Online communities

Distance learners are more likely to feel isolated and can become demotivated, which contributes to typically higher levels of withdrawal from online programmes versus those delivered on-campus (Tyler-Smith, 2006); for example, Patterson and McFadden (2009) observed drop-out rates for online masters programmes exceeding 40%. Student engagement and participation has to be tracked and acknowledged in order to maintain learner motivation (Lomis *et al*., 2017; Teasley and Whitmer, 2017), and successful online programmes typically include sustained tutor-student contact as well as student-student interaction. Discussion boards create a collaborative online community that can reduce feelings of isolation associated with distance courses (Mohamad and Shaharuddin, 2014; Uijl *et al*., 2017), and contribute to increased learning and student satisfaction (Rovai, 2002; Croft *et al*., 2010). Furthermore, asynchronous discussion boards promote greater higher-order learning than face-to-face dialogue since students have more time to reflect upon and research their responses (Brierton *et al*., 2016). However, it is possible for some students to adopt the role of "lurker" (Beaudoin, 2002), in that they may view the discussions posted by others but do not themselves participate. Sharing comparative progress data among students might act as an incentive for lurkers to contribute to online discussions. For example, Bratitsis and Dimitracopoulou (2009) observed that use of interaction analysis tools which show individual student activity, as well as overall class activity, enhanced participation on discussion boards, both quantitatively and qualitatively.

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Dashboards

The concept of using learning analytics to personalise each student's academic experience is becoming a widespread phenomenon across the higher education sector (Gašević *et al*., 2015; Sclater *et al*., 2016). At the outset of this case study, in 2014, learning analytics dashboards were focused predominantly on instructor-facing solutions. The past decade has seen an expanding use of student-facing learning analytics dashboards, which facilitate student autonomy and enhance motivation beyond reporting systems used by teaching or administrative staff (see review by Bodily and Verbert, 2017a). An early adopter of these was Purdue University in the States which, in 2007, piloted Course Signals, a traffic light system to show how students were performing on their courses, which was automated and rolled out across the university in 2009. This simple visualisation tool is followed up with messages from staff suggesting what students need to do to maintain/improve their results. Data from Purdue showed that retention rates were improved and the majority of students increased their grades (Arnold and Pistilli, 2012). The emphasis of early dashboards was on retention rates and performance improvements in students at risk of failing, and many practitioners in the learning analytics field routinely analysed patterns in educational data to create algorithmic models to make predictions on academic performance (Papamitsiou, and Economides, 2014). However, there are dangers in pigeon-holing any student to a predicted trajectory of failure, not least the potential for self-fulfilling prophecy (Dietz-Uhler and Hurn, 2013). Attention has turned to how student-facing dashboards can be used to enhance student learning and reflection. To inform the design of dashboards, we need to understand how students interpret the presentation of data. A study by Corrin and de

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Barba (2015) revealed that while the majority of students were able to interpret the data shown and regarded them as motivational, some struggled to interpret the dashboard in a way that would inform their subsequent learning strategies. As such, the authors recommend that support is provided to students to help them interpret dashboards (Corrin and de Barba, 2015). More recently, Kitto and colleagues provided a persuasive narrative on how to design learner-centred dashboards (Kitto *et al.*, 2017). Their 'do-analyse-change-reflect' approach comprises four phases of learning analytics, the first of which involves students participating in a learning activity; second, an analysis of dashboards relating to the 'do' phase; third, encouraging students to change their behaviour in light of the dashboard data; and finally asking students to reflect on the process. Kitto *et al*. (2017) conclude that dashboards should be integrated into the pedagogical structure of a course, coupled with assessment, to encourage their use in helping students understand and apply the data to achieve their learning goals. It is clear from the above examples that students must be at the centre of dashboard development; any data portrayed within a dashboard must not be open to misinterpretation and staff support must accompany its release.

Social Learning Theory and learner motivation

Observing the behaviour of others and its consequences plays a large part in learning. Bandura's Social Learning Theory describes observational learning as "learning by example", influenced by reinforcement whereby positive incentives can enable action by the learner (Bandura, 1971). Dashboards can be designed with a social reference frame to allow students to compare their progress with peers and modify their behaviour and performance. An example of this is increased learner

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engagement and completion rate in four MOOCs when a social comparison feedback dashboard was utilised (Davis *et al.*, 2017).

Students who are underperforming are the ones to derive most benefit from dashboards, but rank-order data have the potential to provide a negative incentive, and ultimately discourage lower performing students (Cherry and Ellis, 2005). Gašević *et al.* (2015) comment that the negative impact of comparison dashboards on students with low levels of self-efficacy "is a hypothesis commonly heard in the discussions within the learning analytics community". However, there is a growing literature that supports the motivational impact of dashboards (Fritz, 2011; Arnold and Pistilli, 2012; Park and Jo, 2015; Bennett, 2018). Tan *et al.* (2016) reported mixed motivational outcomes in students who were performing below the class average; for some the dashboard stimulated competition through "healthy peer pressure", but for others these data were "demoralizing". A recent study by Teasley and Whitmer (2017) demonstrated that students with a low grade point average (GPA) found the dashboard of more value than their high GPA-scoring peers. Furthermore, the low GPA students reported an increase in motivation after seeing the dashboard (Teasley and Whitmer, 2017). Thus, peer-comparison dashboards have the potential to prompt students at risk of failing into putting more efforts into their study but is by no means a certainty.

This original paper shares student and tutor perspectives on the use of dashboards to increase online students' motivation, and examines whether the benefits of a peer-comparison dashboard are reserved for high-achieving students.

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A case study

Students enrolled on the online, part-time MSc in Surgical Sciences at the University of Edinburgh are all trainee surgeons. In response to changes in surgical training that reduced clinical exposure in the workplace, the MSc in Surgical Sciences (Edinburgh Surgical Sciences Qualification, ESSQ) was established in 2007, led by the University of Edinburgh in partnership with the Royal College of Surgeons of Edinburgh. The MSc delivers an innovative distance learning programme that complements the traditional acquisition of clinical knowledge by surgical trainees, and is the highest recruiting postgraduate course at the University - being taken up by over 1000 trainees in 70 different countries – and attracts around 100 new students each year (Smith *et al*., 2013).

The MSc in Surgical Sciences programme utilises a bespoke virtual learning environment (VLE), designed and delivered by the former Learning Technology Section of the University of Edinburgh. Prior to the current study, each assessment metric was displayed on a different page of the VLE, hence there was nowhere for students - or tutors - to see an overall picture of their progress. In accordance with social learning theory (Bandura, 1971), presenting anonymised, comparative progress data to students may increase learner motivation in online programmes, especially true for surgical trainees who are naturally competitive (Hill *et al.,* 2014).

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Creating the peer-comparison progress dashboard

During the academic year 2014/15, Tableau® visualisation software was used to create a pilot dashboard which allowed progress data to be displayed on a single page in an effort to provide clear, easy readable and interpretable graphs. Years 1

and 2 of the Masters programme each ran as a course of 20 consecutive modules, with a single, aggregate end-of-year mark. Students were assessed on completion of in-course multiple-choice questions (MCQs), discussion board contributions, essays (Y2 only), and a final written examination. The relative weighting of in-course assessment was 25% in Y1, and 40% in Y2. Included in the dashboard were all the metrics readily captured from the VLE for cumulative modules. These comprised number of logins, number of discussion board posts, percentage score for posts, percentage essay mark, and percentage of the total MCQs completed (a total of 1422 MCQs were released sequentially during the year). Once the template dashboard was created in Tableau®, involving a simple 'drag-and-drop' approach to the layout, data were then imported from an Excel spreadsheet file. Subsequent iterations were easy to perform, whereby a single file upload automatically updated the dashboard template. For 2015/16, the pilot dashboard was refined to include a class-ranking tab and a pie-chart illustrating modules included in the analysis, and this version of the dashboard has been used in subsequent years. To view the dashboard, students first had to download the Tableau® Reader desktop application before opening the file sent as an email attachment from their personal tutor to their University of Edinburgh e-mail account. Each student received a unique identification number with the first dashboard in order to view their individual data highlighted from the class data.

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Tutor intervention

The data presented in the dashboards were used to provoke e-mail correspondence with students who appeared to be falling behind in their studies. The dashboard was referred to purposely in the opening sentence of personal tutor e-mails to students,

e.g. "*I am e-mailing you because the student dashboard indicates that you have not contributed very much to the discussion boards to date, nor have you attempted any of the MCQs on the VLE".* In follow-up 1:1 personal tutor meetings, advice was given to these students around equitable participation, adressing potential barriers to discussion board contribution such as feelings of intimidation and/or dominant peers (Symeonides and Childs, 2015). In order to monitor the progress of *all* students in a cohort and avoid focusing efforts exclusively on poorly performing students, modified e-mails were sent after the release of each dashboard to students who were performing at the required level or above. For example, "*Further to the release of the progress dashboard today, I wanted to let you know that so far you are on-target to achieve the 40% threshold required for the in-course assessment. Your average mark this far is ≥50%, so well done and keep up the good work!*".

Student perceptions

To evaluate the perceived effectiveness of the progress dashboard, a Web-based anonymous survey was issued to students on the programme between 2014/15 and 2017/18 (distributed by e-mail). A 3- (yes, unsure, no) or 5-point Likert Scale (strongly disagree, disagree, neither disagree nor agree, agree, strongly agree) was used for scoring purposes. The survey consisted of questions relating to the ease of technical use and comprehension of the dashboard, as well as students' perceptions of its usefulness as a feedback tool and their emotive responses to it (Appendix). The content validity of the survey instrument was evaluated by an external expert (Project Manager of the 'Student Analytics VLE Investigation' project 2013-14, Information Services Group – Technology Enhanced Learning, University of Edinburgh). Survey reliability was assessed using Cronbach's alpha (α) to estimate internal consistency

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between responses to the two questions on 'motivation' and 'change in study patterns': α = 0.75 indicating satisfactory reliability. In 2017/18, to incentivise completion of the survey students were invited to enter a prize-draw for a £50 gift-voucher (details entered on a separate page to preserve anonymity). The survey ran for the entire academic year – single completion permitted - following release of the first instance of the dashboard. Student free-text responses were screened to identify common themes until saturation, i.e. no additional themes were found. Institutional ethics approval was not required owing to the anonymous nature of the survey instrument and the voluntary participation of students. Subjective evaluations from students were compared with objective evaluations of full cohort in-course participation. Data relating to discussion board posts and MCQ attempts during 2014/15 – 2017/18 were compared pre- and post-dashboard release using a paired Student's t-test (IBM SPSS Statistics for Windows, Version 24.0). Rank-order change data for low-, middle- and high-achieving students were analysed using one-way ANOVA (GraphPad Prism 8).

Student retention

It was not the express aim of this study to evaluate the impact of the dashboard on students' retention on the Masters programme. However, in order to establish that the dashboard did not have a negative influence on retention, data relating to withdrawal rates across the four years pre- (2010/11 – 2013/14) and post- (2014/15 – 2017/18) dashboard implementation were collated for Year 1 and Year 2 of the programme (the third year is dedicated to an independent research project), and proportions compared using a Chi-Square test (IBM SPSS Statistics for Windows, Version 24.0).

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Findings

Dashboards

The progress dashboard was designed to display metrics relating to the continuous assessment components of the Masters programme. A key feature of the dashboard is the interactive element, whereby a student selects their unique, confidential identification number from a drop-down list, and their data then become highlighted from the rest (Figure 1). Average marks for the class are shown as a line in each of the bar graphs. Progress dashboards were released four times in the academic year between November and May. In relation to social learning theory, students have the opportunity to monitor their improvement over time and, with increased course participation, observe better scores and class-ranking (intrinsic reinforcement). Students can click on the data points for top-performing students to reveal activities - number of logins and posts - associated with high scores as an incentive to modify their own study behaviours (observational learning).

Tutor intervention

Progress dashboard-prompted e-mails generated a higher response rate (~40%) from students than previous correspondence (~10%) issued before the introduction of dashboards. The following e-mail excerpt is a typical example of how students appreciate a 'virtual nudge':

> "*Thank you for your email. Sometimes it's nice to get a gentle reminder to get jolted out of the rut one finds oneself in*".

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Student perceptions

A total of 137 students responded to the questionnaire, which represents 16% of the total cohorts completing the academic year between 2014/15 to 2017/18 (n=846). The response rate for students in Years 1 and 2 of the programme was comparable: 79/500 (16%) for Year 1, and 58/346 (17%) for Year 2. While the average response rate was 10% between 2014/15 and 2016/17, this rose to 39% in 2017/18 (most likely due to introduction of a gift-voucher prize-draw for completion), and data reveal comparable responses among the four cohorts, diminishing the effect of non-response bias (P-values ranged 0.10 - 0.26 for first versus last cohort responses, Mann-Whitney U test). It is not clear how many students overall viewed the dashboards since they were issued as an email attachment, i.e. students had to opt-in.

{Insert Table 1 here}

Student feedback provided affirmative endorsement of the dashboard (Table 1). The majority (83%) found the data easy to interpret. Ninety-four percent of respondents found the data relating to their engagement in the MSc very useful (75/137) or somewhat useful (53/137); only 1 out of 137 found them unhelpful (Table 1). Fifty-five percent of respondents said that they will change their approach to study (e.g. completing more MCQs) as a result of seeing the data; 32% do not think that they need to change anything; 13% said they would effectively ignore the data (Table 1).

Figure 2 displays the changes in two student engagement measures from first and final release of the dashboard over an academic year. Analysis of which students benefitted from the dashboard, in terms of low-, middle- or high-achievers, was conducted after grouping student data retrospectively based on end-of-year

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performance quartiles. Although the survey was anonymous, entrants for its associated prize provide insight into the groups viewing the dashboard, i.e. act as a surrogate marker of dashboard use. Of the fifty students who completed the survey and entered their details into the prize-draw, the majority were in the middle 50% for end-of-year performance scores (Figure 3A). The impact of dashboard use on class rank improvement, based on continuous in-course assessment scores, revealed no significant difference between low-, middle- and high-achievers (P=0.53, one-way ANOVA) (Figure 3B). These findings are supported by heat map visualisations of student VLE activity; top-performing students typically do not reduce their study patterns following dashboard release but those in the bottom 25% are prompted to engage in study (Figure 3C).

{Insert Table 2 here}

Student responses were generally positive, as revealed by the free-text quotes given in the questionnaire (Table 2). The most common theme to emerge was around peer-performance/class ranking, whereby comparing oneself to others appears to have had a motivational effect, promoting a competitive edge to learners' engagement. Some students experienced technical issues with the Tableau® software, and several questioned the value of the data displayed.

The top three adjectives selected by students were '*interested*', '*encouraged*', and '*motivated*' when asked to describe how they felt when viewing the dashboard data (Figure 4). Despite several students expressing negative emotions, 100% of respondents indicated that they would like to receive regular updates of the student progress dashboard. A plurality (50%) indicated that they would like them made available on a monthly basis, and no-one selected the option 'never'.

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Student retention

Comparison of withdrawal data pre- and post-implementation of the dashboard reveals a decrease in students leaving the programme post-implementation of the dashboard: 91/755 (12.1 ± 4.9%) versus 75/946 (7.9 ± 2.9%); $P<0.05$. Because this was not a controlled study, it is not possible to attribute the decrease to a causal effect of the dashboard.

Practical implications

The focus of the current study was on student-facing dashboards to allow online students to view their progress in relation to geographically-distant peers, and to provide personal tutors with a visual tool to quickly ascertain an individual student's engagement with in-course assessment activities. Results herein suggest that providing students with a progress dashboard of cohort comparison data is motivational. While rank-order data can discourage lower performing students (e.g. Wise *et al*., 2014), the findings of the current study suggest that this did not occur; even the five students who expressed that they felt demotivated by the dashboard data responded that they still wished to receive monthly updates. It is likely that the extent to which a student is motivated to learn is determined by their motivational belief, be it intrinsic or extrinsic (or amotivation). Identifying the motivational characteristics of students is beyond the scope of this study but will be important in strengthening the link between dashboards and engagement outcomes. A systematic review in 2018 by Jivet and colleagues concluded that peer-comparison dashboards should be used cautiously; contrasting studies found both positive and negative

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effects of dashboards on student engagement and further research is warranted to understand differences between learners (Jivet *et al*., 2018). Thus, instructors need to consider carefully the appropriateness of comparison and competition among their particular student cohorts. While such a peer-ranking system may not be appropriate in every setting, all of the students enrolled on the MSc in Surgical Sciences are trainee surgeons and, by definition, they have entered a very competitive field and are familiar with class-ranking from their undergraduate medical education.

The positive response from students on the perceived usefulness of dashboards is in agreement with the literature (Verbert *et al*., 2014; Yoo *et al*., 2015). For a better measure of their effectiveness, Bodily and Verbert (2017b) recommend asking students about the perceived effect on behavior/study patterns. In this study, the majority of respondents indicated that they will change their approach to study in light of the dashboard data. Use of progress dashboards can stimulate participation in online assessment activities, as this student quote from the current study reveals:

> "*I now have a greater appreciation of assessment weighting and will prioritise case discussion posts over completing the module"*.

Owing to the anonymous nature of the study, it is not possible to verify whether students did increase their in-course participation as implied. However, an objective analysis of MCQ completion and discussion board participation following release of the dashboard supports a positive change in students' study behaviours. Furthermore, subgroup analysis of survey prize entrant data to ascertain the impact of the dashboard on academic performance of individual students reveals no difference between low-, middle- and high-achievers in terms of class-rank gain.

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Some students expressed doubts about the accuracy and value of the data. This can be explained by the lag time in data capture and dashboard release in relation to the current module running in the programme. As a response to confusion expressed by a few students around which data account for their progress view, the pie chart depicting specific modules included in the dashboard was added after the first year of piloting the dashboard. Park and Jo (2015) stress the preference for dashboard data to be objective and trustable, and not related to any kind of evaluation. It was made clear to students on the MSc in Surgical Sciences that the dashboard was only released to students and the personal tutor and did not form part of any evaluative process.

Tutor intervention

This case study used the dashboard as a fast tool for identifying those students falling behind in their studies, as measured by their level of VLE engagement and marks for in-course assessment, and then intervening via e-mail to (a) alert the student of their position, and (b) discuss the reasons for their performance, and advise on ways to improve. Interestingly, progress dashboard-prompted e-mails have generated a higher response rate from students than previous correspondence simply commenting on their progress, and may be viewed as a proxy to changing behaviours. This possibly relates to the visual nature of a graph carrying more authority than if the data were presented as text, a list or table. Indeed, it has been shown that people are more likely to be persuaded by graphical representations of data compared to the same information in text format (e.g. Nyhan and Reifler, 2018). In the learning analytics arena, communicating progress data to students as dashboards of charts allows for ease of transmission, but there is a risk that graphs

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could be misinterpreted by some and carry disproportionate meaning (Alltree *et al*., 2014). With that awareness, tutors must ensure supportive lines of communication exist between themselves and the student to avoid a negative graphic of progress resulting in disengagement with the learning environment.

The dashboard has acted as a conversation catalyst during tutor-student meetings. For a student to see where they rank in relation to their peers, and the class average, makes for a more meaningful discussion on their progress and setting achievable goals. Prior to the dashboard, tutors would have to check on multiple pages within the VLE and on spreadsheets offline in order to build up a picture of how a student was engaging with the programme. Now, the dashboard provides an instant view, which is especially convenient if a student chooses to telephone their tutor on-the-fly to discuss their studies. This is important since accessibility of the personal tutor is a key determinant of student uptake (Walsh *et al*., 2009).

Student retention

While there was an appreciable ‘drop-out’ rate from the programme each year (5-15%), this is less than that observed in other distance learning masters programmes; (e.g. 40% reported by Patterson and McFadden, 2009). The higher retention rates for the online MSc in Surgical Sciences likely reflect the programme attracting competitive, highly motivated and dedicated surgical trainees who demonstrate study behaviours that promote successful academic outcomes (Stienen *et al*., 2018). The introduction of a progress dashboard was associated with an average 4% decrease in number of student withdrawals on the MSc in Surgical Sciences. This is in agreement with findings from other institutions (e.g. Arnold and Pistilli, 2012),

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although the confounding effect of additional factors unrelated to the dashboard cannot be ruled out. Since this was an observational study, not involving a control/intervention group comparison, it would be naïve to attribute the improved retention solely to the dashboard/tutor intervention. Nevertheless, it is clear that withdrawal figures did not *rise* with the introduction of progress data, thus countering concerns around their potential negative impact.

Study Limitations

The low response rate to the questionnaire may have resulted in non-response bias; there is a potential for high performers to view the dashboard attachment and complete the survey. However, entries received for the voucher prize in 2018, and dashboard-prompted email correspondence from students to their personal tutor in the earlier years, suggest students from a wide range of rankings participated in this study.

Dashboards were released to students via email attachment. A major uncertainty in this study is the relative use of University e-mail accounts by students. A recent literature review of student-facing learning analytics reporting systems reports a low use of dashboards by students (Bodily and Verbert, 2017a), and its authors advocate future research to examine how to increase student use of such tools.
Acknowledging student feedback on technical issues downloading the necessary software, steps to incorporate the dashboard tool into the VLE in future iterations are justified, but the primary reason for email release was to ensure supportive communications accompanied the dashboard.

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The survey data collected in this study represent static data, i.e. responses at a single time point were captured. Dynamic relationships between the dashboard data and student views would be an interesting aspect to pursue future iterations, since students are likely to have varying perceptions of their progress and motivation throughout the course (Pardo *et al*., 2017).

Conclusion

Presenting anonymised comparative progress data to students may increase learner motivation in online, distance learning programmes, especially true for surgical trainees who are naturally competitive. Students value being able to see their ranking alongside geographically disparate peers and it can incentivise a change in study behaviours. Progress dashboards provide a convenient and efficient means for personal tutors to monitor students' progress quickly, at a glance, and can be used as a catalyst to identify 'at risk' students and affect interventions in order to assist students in taking greater ownership of their learning and facilitate achievement of their potential. Clearly, there are differences in learner motivations resulting from dashboards and a subset of students for whom this is particularly useful. Future research is recommended to identify the characteristics of students who will benefit most from peer-comparison dashboards and to design effective alternative strategies for others to best monitor their progress.

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Figure 1. Example of the dashboard issued to students on the MSc in Surgical Sciences programme, which includes virtual learning environment (VLE) metrics and assessment scores. Highlighted student 'ID #54' metrics shown in orange.

Figure 2. Student engagement data. **Left:** Percentage of available multiple choice questions (MCQs) attempted, captured for the first and final dashboard release in an academic year (mean±SD). **Right:** Number of discussion board posts made each week (mean (range)). * P<0.01; paired Student's t-test (*n* = 800, which represents all Y1 and Y2 online students enrolled between 2014/15 and 2017/18, excluding those on interruptions of study and withdrawals).

Figure 3. The influence of student achievement status on dashboard outcomes. (**A**) Percentage of students within the first, second/third, and fourth end-of-year performance quartile who entered the survey prize (*n* = 50). (**B**) High-, middle- and low-achieving students' gain in class rank following dashboard use. Bar = mean (P=0.53, one-way ANOVA). (**C**) Example heat map visualisations of VLE activity in the week pre- and post-release of dashboard for Y1 students in the top 25% of students (upper panel), and the bottom 25% of students (lower panel) for end-of-year performance. Data are displayed as day of week (y-axis) vs. hour of day (x-axis); blue dashed-line = the time of completion of survey/access to the dashboard.

Figure 4. Student responses to the survey question, "*How do the data presented in the dashboard make you feel*?". Survey participants could choose more than one option. Black bars indicate positive reactions, with negative emotions shown in grey.

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Fig1.

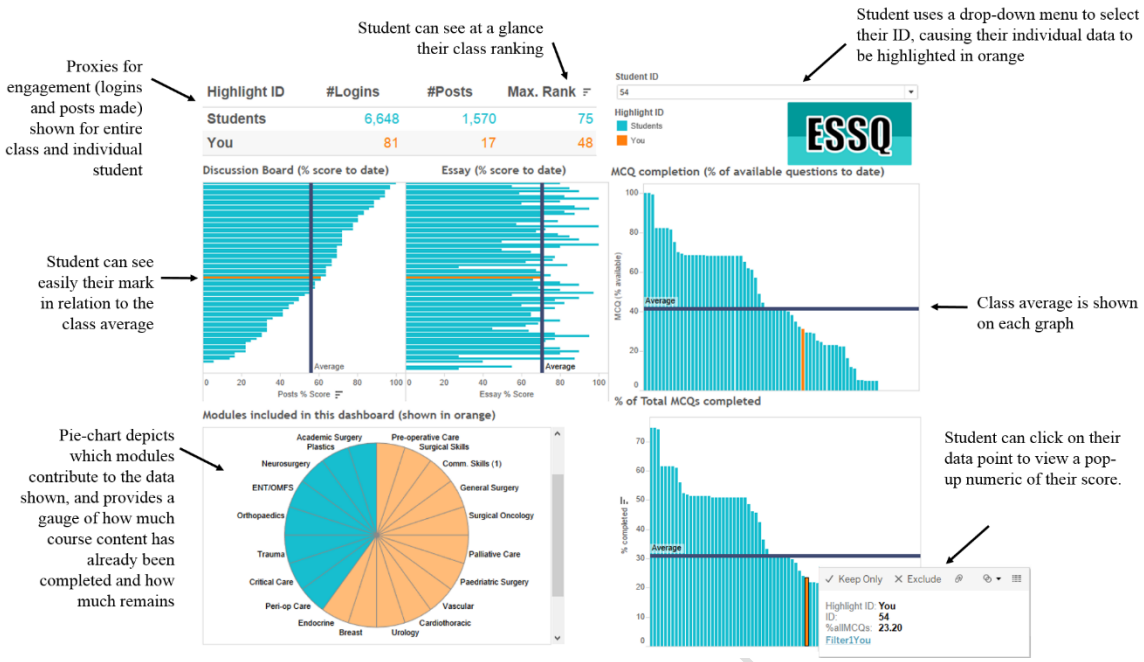
Student can see at a glance their class ranking
Student uses a drop-down menu to select their ID, causing their individual data to be highlighted in orange
Proxies for engagement (logins and posts made) shown for entire class and individual student
Highlight ID
#Logins
#Posts
Max. Rank
Students
6,648
1,570
75
You
81
17
48
Student ID
54
Highlight ID
Students
You
ESSQ
Discussion Board (% score to date)
Essay (% score to date)
MCQ completion (% of available questions to date)
Student can see easily their mark in relation to the class average
Average
Posts % Score
Essay % Score
MCQ (% available)
Class average is shown on each graph
Modules included in this dashboard (shown in orange)
Pie-chart depicts which modules contribute to the data shown, and provides a gauge of how much course content has already been completed and how much remains
Academic Surgery
Plastics
Pre-operative Care
Surgical Skills
Comm. Skills (1)
Neurosurgery
ENT/OMFS
General Surgery
Orthopaedics
Surgical Oncology
Trauma
Palliative Care
Critical Care
Paediatric Surgery
Peri-op Care
Vascular
Endocrine
Cardiothoracic
Breast
Urology
% of Total MCQs completed
% completed
Student can click on their data point to view a pop-up numeric of their score.
Keep Only
Exclude
Highlight ID: You
ID: 54
%allMCQs: 23.20
Filter1You

Fig. 2

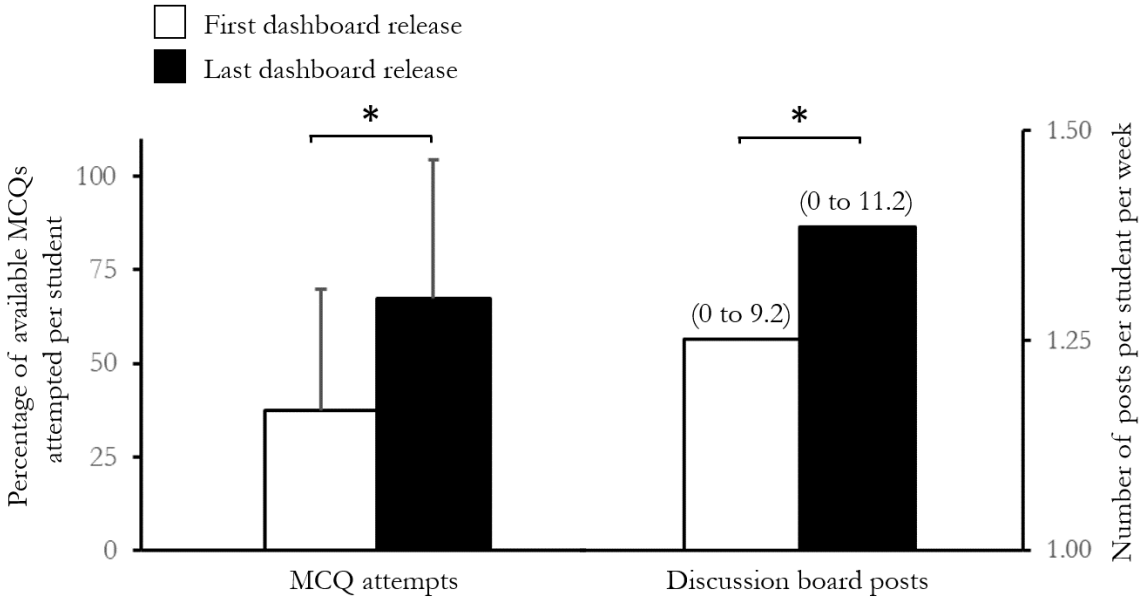
First dashboard release
Last dashboard release
*
*
Percentage of available MCQs attempted per student
100
75
50
25
0
(0 to 9.2)
(0 to 11.2)
1.50
1.25
1.00
Number of posts per student per week
MCQ attempts
Discussion board posts

Fig. 3

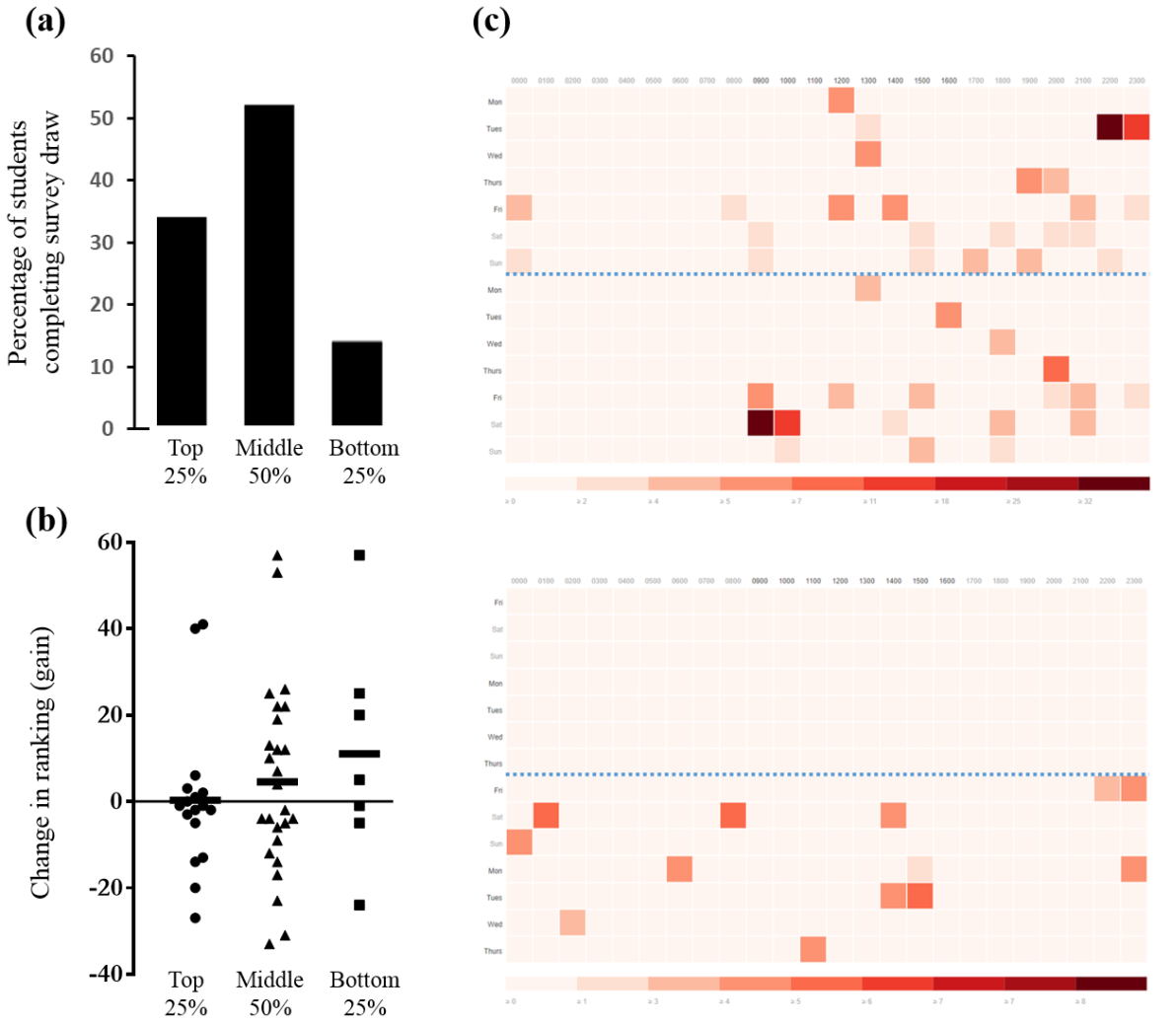

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Fig. 4

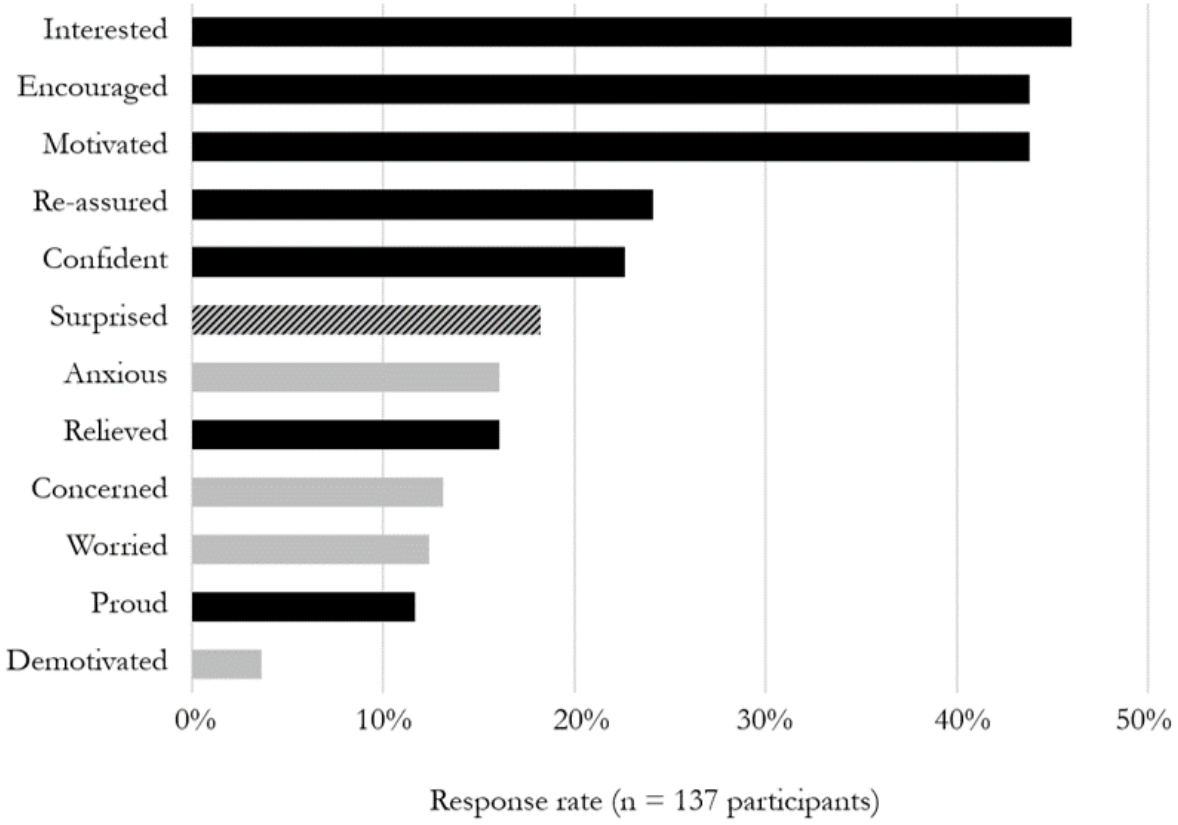

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Table 1. Student responses to 3- and 5-scale questions.

Question	No, unhelpful	No, not really	Unsure	Yes, somewhat	Yes, a lot
1. Did you find the data relating your course engagement useful?	1 (1)	4 (3)	4 (3)	53 (39)	75 (55)

Question	Yes	No	Unsure
2. Did you find the graphs easy to interpret?	113 (83)	9 (7)	14 (10)
3. Would you prefer the data to be presented in a different format?	20 (15)	81 (59)	36 (26)
4. Would you like to see additional/different metrics relating to your engagement?	32 (24)	102 (76)	-
5. Do you perceive the data provision as an element of feedback?	118 (87)	8 (6)	10 (7)
Question	**Yes, I will most likely change**	**I don't think I need to**	**No, effectively ignore**
6. Will you change your study patterns in light of these data?	75 (55)	44 (32)	17 (13)
Question	**No problem**	**Uneasy**	**Neutral**
7. How would you feel about discussion relating to the data within your personal tutor meeting?	82 (61)	3 (2)	49 (37)

Data are shown as number of respondents, with percentage of total number of respondents in brackets (n=137 for Q1 and 3; n=136 for Q2, 5 and 6; n=134 for Q4 and 7, owing to some skipped questions).

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Table 2. Analysis of free-text comments from the online survey revealed common themes relating to the student progress dashboard.

Emerging themes	Sample quotes
Awareness of others in class / relative ranking	*"It's very useful in online education delivery to be able to compare yourself to other students. It has been my worry, that I was not keeping up, or that I was at risk of failure. The data reassured me as to this"* *"It feels like I'm not alone in this anymore- there are other people and we are all working on the same thing. It's nice to gauge where I am at compared to others"* *"Very helpful to see how much work everyone has done as we don't see each other"* *"Useful to see each essay scored against other student's performance. It tells if the essay was generally easy or hard to all of us and where I stand with my performance"* *"Gives us a chance to understand what other people (aside from just our group) in the course are doing and how you're tracking compared to the rest of the cohort"*
Motivation	*"Getting close to exam period and I have started to prepare for this. I would have increased completion of MCQs regardless of this data but it is useful as a motivational tool to increase engagement"* *"With it being a distance online learning programme, it's very easy to get carried away with work and personal life, and unfortunately sometimes end up neglecting ESSQ. I always find that the data which shows me how much I'm engaging either relaxes my mind or pushes me that much more to get through"* *"It looks as if I've fallen behind with contributing to discussion boards. This is something I already knew, but didn't realize I had fallen behind to that extent! I will make it a point to sit down more to contribute to the discussion board, on top of what I'm already doing"* *"It was a nice surprise - I wasn't expecting to be doing so well, so it motivated me to keep it up!"*
Competition	*"I think it is easier to engage when there is a little more competition going on"* *"Knowing our study patterns in relation to other peers are a very interesting mode to generate motivation and competitiveness in the programme we are attaining"*

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	"It adds a bit of competitiveness to the whole thing which I think is a good source of motivation"
Technical issues	*"I mean it's good to get the update. But it's annoying to install a program that's 250mb just to do this. One which will never be used again"* *"Large application, needed to clear out some space in my drive for it"* *"If it could be presented via the university website itself that would be preferable. Downloading a program specifically to look up the results seems wasteful and no need for the program other than this purpose"* *"I was unable to use the software on my MacBook"*
Data / lag time	*"It's a measure of engagement, not directly related to performance, i.e. a person who's done more MCQs will score higher regardless if they've scored poorly"* *"I am not sure how accurate the data is as I seem to have done much more MCQs than the graph actually says I've done"* *"Qualitative feedback on my contributions to the board would be far more useful than a graph"*

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